Table 7-5-1: Degraded Splice					
Situation	Recommendation				
1. Any high current circuit with one of more of the conditions identified below.	This finding is relatively infrequent. Pre-emptive replacement of spliced wire with new wire or the rework of splices can minimize the potential for repairs or splices to degrade beyond acceptable limits. Any repair should be accomplished using OEM/FAA approved methods and materials appropriate for the environment (which may exceed the requirements of originally approved practice for aged aircraft). Periodic diagnostic testing (e.g. resistance evaluation, time domain reflectometry) can help to identify failing (high resistance) repairs and splices.	**OWNER**	**ECD**	**LAST**	**THIS**
	1.1 Task Group 4: Update splicing practices as necessary. Consider procedure to tag locations of splices to aid in future visual inspections.	Task 7	Jan 02		
	Incorporation Plan: (TBD)				
	1.2 Task Group 5: Update training guidelines on a regular basis to correspond to ESPM updates. Emphasize the need to inspect splices closely for obvious deterioration as well as proper materials and workmanship.	Task 8	June 02		
	Incorporation Plan: Incorporate wiring splice inspection and selection in Inspection and wiring modules				
	1.3 Aircraft Manufacturers: Where appropriate utilize design practices which facilitate the repair of electrical interconnect systems without the need for splices. Develop splice vs. replacement of wire guidelines.	Task 6	June 02		
	Incorporation Plan:				
	1.4 Aircraft Operators: Review initial and proficiency training practices for splice installation and inspection. Ensure full awareness of approved materials and techniques.	Task 6	June 02		
	Incorporation Plan:				
	1.5 Other: The FAA should revise AC 43-13-1B to stipulates that environmental splices are the preferred method of repairing wire in both SWAMP and non-SWAMP areas. Develop wiring configuration management software that will track the installation and location of splices.	Task 6	June 02		

	Develop best practices regarding the maximum number of splices permitted for various types of circuits based upon frequency and severity of potential splice failures. **Incorporation Plan:**				
1a. Potential for high resistance heating, flammable materials	Given the specified conditions, the occurrence of this fault could lead to potentially critical consequences. In this situation the potential for fire exists. 1a1 Aircraft Manufacturers: Consider updating splicing practice to reflect special considerations associated with 1) the proximity of the splice to non-fire-retardant materials and 2) the expected wire current. **Incorporation Plan:**	**OWNER**	**ECD**	**LAST**	**THIS**

Table 7-5-2: Heat Damaged or Burnt Wire					
Situation	Recommendation				
2. Any situation with one or more of the specific conditions identified below	This finding is relatively common. Localized heat damage (from external source or internal conductor heating) on adjacent wires may make these wires particularly subject to the formation of neighboring cracks and the potential for arcing or shorting. Visual Inspection can detect some conditions. Use of in-situ nondestructive testing methods may be used to detect additional insulation faults, especially if the heat damage effects a local area with several bundles, several wires within a single bundle, or a substantial length of a single wire. 2.1 Task Group 3: Modify the MSG3 process to include the consideration of potential heat sources when developing zonal inspection instructions **Incorporation Plan:** 2.2 Task Group 4: Insure heat shield installation and maintenance are appropriately specified. **Incorporation Plan:** 2.3 Task Group 5: Review visual indications of overheating in order to more precisely characterize symptoms of heat-degraded wire. **Incorporation Plan:** 2.4 Aircraft Manufacturers: Review design and maintenance practices regarding the use heat shields. Establish on-condition criteria for the replacement of wire in heat-damaged bundles (external and internal heat). Develop and implement configuration management processes to prevent load creep that may result in circuits operating near the rated capacity and conductor heating. **Incorporation Plan:** 2.6 Aircraft Operators: Ensure awareness of the heat-shield requirements and proper maintenance. **Incorporation Plan:**	**OWNER**	**ECD**	**LAST**	**THIS**

	2.7 Other: Develop diagnostic technologies and techniques to identify and prevent the development of high resistance interconnects. **Incorporation Plan:**				

2a. Flammable materials, cockpit or electronics bay.	Given the specified conditions, the occurrence of this fault could lead to potentially critical consequences. Though the specific presence of moisture or contamination (to enable short circuiting) is not necessarily anticipated in this scenario, the specified zones and installations within these zones are critical enough to warrant extra care and precaution. 2a1 Task Group 3: Investigate periodic, selective inspection and nondestructive testing of cockpit and electronics bay wiring. **Incorporation Plan:** 2a2 Aircraft Manufacturers: Investigate periodic, selective inspection and nondestructive testing of cockpit and electronics bay wiring. **Incorporation Plan:** 2a3 Aircraft Operators: Investigate periodic, selective inspection and nondestructive testing of cockpit and EE bay wiring. Accelerate removal of flammable materials from the cockpit and electronics bay. **Incorporation Plan:**	**OWNER**	**ECD**	**LAST**	**THIS**

2c. Moisture, flammable materials	Given the specified conditions, the occurrence of this fault could lead to potentially severe consequences. Effective intervention can include reduction of moisture intrusion, minimization of flammable materials in the proximity of susceptible installations, and installation of fire or heat barriers. 2c1 Task Group 4: Insure that drip guard installation and maintenance are appropriately specified. **Incorporation Plan:** 2c2 Aircraft Manufacturers: Review design practices regarding the use of drip guards for this specific situation. Investigate the use of nondestructive testing to troubleshoot suspect wire installations. **Incorporation Plan:**	**OWNER**	**ECD**	**LAST**	**THIS**

2d. Moisture, multiple critical systems	Given the specified conditions, the occurrence of this fault could lead to potentially severe consequences. Though the presence of flammable materials is not anticipated in this scenario, the potential for a common mode failure of many or all wires in a single bundle warrants extra care and precaution. Effective intervention can include reduction of moisture intrusion and installation of fire or heat barriers. Proper separation of critical systems wiring will mitigate the consequence of collective wire failure. 2d1 Task Group 3: 2d2 Task Group 4: Insure that drip guard installation and maintenance are appropriately specified. **Incorporation Plan:** 2d3 Aircraft Manufacturers: Review design practices regarding the use of drip guards. Investigate use of nondestructive testing to trouble-shoot suspect wire installations. Investigate use of nondestructive testing to trouble-shoot suspect wire installations. **Incorporation Plan:** 2d4 Aircraft Operators: Investigate separation and segregation of wire installed after manufacture of the aircraft. **Incorporation Plan:**	**OWNER**	**ECD**	**LAST**	**THIS**

2e. Flammable materials or contamination, multiple critical systems	Given the specified conditions, the occurrence of this fault could lead to potentially severe consequences. The potential for a common mode failure of many or all wires in a single bundle warrants extra care and precaution. <u>2e1 Task Group 3:</u> <u>2e2 Task Group 4:</u> Ensure that wiring separation and segregation guidelines that consider loss of multiple critical functions from a common mode failure are specified. **Incorporation Plan:** <u>2e3 Aircraft Manufacturers:</u> Investigate use of nondestructive testing to trouble-shoot suspect wire installations. Review sources of potential contamination. Investigate use of nondestructive testing to trouble-shoot suspect wire installations. **Incorporation Plan:** <u>2e4 Aircraft Operators:</u> - Investigate separation and segregation of wire installed after manufacture of the aircraft. Review sources of potential contamination. **Incorporation Plan:**	**<u>OWNER</u>**	**<u>ECD</u>**	**<u>LAST</u>**	**<u>THIS</u>**

2f. Flammable materials, multiple critical systems, vibration	Given the specified conditions, the occurrence of this fault could lead to potentially severe consequences. Though moisture is not anticipated in this scenario, the potential for vibration (i.e. the relative motion of partially exposed conductors) to induce a common mode failure of many or all wires in a single critical bundle warrants extra care and precaution. Effective intervention can include reducing vibration potential with additional bundle security (clamps, ties, etc) and minimizing flammable materials in the proximity of susceptible installations. 2f1 Task Group 3: 2f2 Task Group 4: Ensure that wiring separation and segregation guidelines that consider loss of multiple critical functions from a common mode failure are specified. **Incorporation Plan:** 2f3 Task Group 5: Insure that training adequately addresses wire bundle segregation, clamp and tie best practices specifically with regard to high vibration areas. **Incorporation Plan:** 2f4 Aircraft Manufacturers: Review design practices regarding the clamping and tying of wire bundles. Investigate use of nondestructive testing to trouble-shoot suspect wire installations. **Incorporation Plan:** 2f5 Aircraft Operators: Investigate use of nondestructive testing to trouble-shoot suspect wire installations. Investigate separation and segregation of wire installed after manufacture of the aircraft. **Incorporation Plan:**	**OWNER**	**ECD**	**LAST**	**THIS**

Table 7-5-3: Vibration Damage or Chafing

Situation	Recommendations				
3. Any Situation involving one or more of the conditions identified below	This finding is relatively common. If the chafing agent is a conductive to ground or if multiple adjacent wires are chafing, short-circuiting can occur even in the absence of moisture or a conductive contaminant (i.e. through direct physical contact). Augmenting general visual inspection with a detailed or directed visual inspection in critical areas can mitigate this condition. The necessity for rework or redesign may result from identification of chronic or widespread chafing condition. An AFCB can mitigate this condition by minimizing damage and preventing electrical fire. <u>3.1Task Group 3</u>: For these high consequence situations, specify more detailed inspection (possibly requiring some disassembly of support hardware) to ensure potential chafing problems are spotted and corrected. **Incorporation Plan** <u>3.2 Task Group 4:</u> Develop a catalog of unacceptable wire bundle configurations. **Incorporation Plan** <u>3.3 Task Group 5:</u> Develop enhanced training to ensure proper mechanical use of OEM/FAA approved tie downs, clamps, and wire separation/segregation are used in areas were wires or cables cross or come in contact. Ensure maintenance personnel recognize potential areas of chafing. **Incorporation Plan** <u>3.4 Aircraft Manufacturers:</u> Continue development of arc-fault circuit breaker technology. Develop generic implementation plans for the potential retrofit of arc-fault circuit breakers onto in-service aircraft. **Incorporation Plan**	**<u>OWNER</u>**	**<u>ECD</u>**	**<u>LAST</u>**	**<u>THIS</u>**

	3.4 Aircraft Operators: Ensure that maintenance personnel are aware of the need to verify the security of all mounting hardware (i.e. specify tactile inspection). Develop generic implementation plans for the potential retrofit of arc-fault circuit breakers onto in-service aircraft. **Incorporation Plan**				
3a. Flammable materials or contamination, cockpit or electronics bay	Given the specified conditions, the occurrence of this fault could lead to potentially critical consequences. Wire or wire bundle chafing in the presence of flammable materials in the cockpit or electronics bay could result in wire-to-structure or wire-to-wire shorting arcing resulting in fire. Flammable contaminants increase the potential for ignition. More emphasis on cleaning and prevention of fluid contamination (e.g. drip shields) can mitigate the risks presented by contaminants and aid in the detection of chafing conditions. Nondestructive testing can detect wire chafing (after significant dielectric breakdown) and aid in repair. 3a1 Task Group 3: Develop situation-specific guidance to ensure the proper attention to protection and cleaning wire bundles. Develop guidance on the separation of wire bundles from non-fire-retardant materials. **Incorporation Plan** 3a2 Task Group 4: Specify situation-specific standards to ensure wire bundles are properly protected and cleaned based on OEM approved practice. Specify nondestructive testing procedures for validating wire integrity in response to undiagnosed malfunctions of cockpit electrical equipment. **Incorporation Plan** 3a3 Aircraft Manufacturers: Develop design modification to minimize potential for contamination. **Incorporation Plan**	**OWNER**	**ECD**	**LAST**	**THIS**

3b. Flammable materials or contamination, multiple critical systems	Given the specified conditions, the occurrence of this fault could lead to potentially critical consequences. Wire chafing in the presence of flammable materials or contaminants with wires from multiple critical systems in close proximity could result in smoke and/or fire and loss of multiple flight-critical systems. Maintaining wire segregation for critical and redundant systems can mitigate the risk of multiple system failures. More emphasis on cleaning and prevention of fluid contamination (e.g. drip shields) can mitigate the risks presented by contaminants and aid in the detection of chafing conditions.	**OWNER**	**ECD**	**LAST**	**THIS**
	3b1 Task Group 3: Develop situation-specific guidance to ensure the proper attention to protection and cleaning wire bundles. Develop guidance on the separation of wire bundles from non-fire-retardant materials. **Incorporation Plan** 3b2 Task Group 4: Specify situation-specific standards to ensure wire bundles are properly protected and cleaned. Specify updated wiring separation and segregation guidelines that consider loss of multiple critical functions from a common mode failure. Specify nondestructive testing procedures for validating wire integrity in response to undiagnosed malfunctions of flight critical equipment. **Incorporation Plan** 3b3 Aircraft Manufacturers: Develop design modification to minimize potential for contamination. **Incorporation Plan** 3b4 Other: Develop and understanding of how vibration and contamination (solid and liquid) interact. **Incorporation Plan**				

3c. Multiple critical systems, arc tracking potential	Given the specified conditions, the occurrence of this fault could lead to potentially critical consequences. Wire chafing with arc tracking potential and wires from critical systems in close proximity could result in arcing and propagation to other wires, smoke and/or fire, and loss of multiple critical systems which can lead to excessive crew workload. 3c1 Task Group 3: Specify guidelines to ensure the proper attention to protection and cleaning wire bundles. Develop guidance to ensure the proper attention to protection of wire bundles. **Incorporation Plan** 3c2 Task Group 4: Specify situation-specific standards to ensure wire bundles are securely fastened and out of harm's way. Develop situation specific wiring separation guidelines that consider loss of multiple critical functions from a common mode failure. Specify nondestructive testing procedures for validating wire integrity in response to undiagnosed electrical malfunctions. **Incorporation Plan**	**OWNER**	**ECD**	**LAST**	**THIS**
3d. Flammable materials	Given the specified conditions, the occurrence of this fault could lead to potentially severe consequences. Wire chafing in the presence of flammable materials can lead to arcing, smoke and /or in-flight fire and increased crew workload. Augmenting general visual inspection with a detailed or directed visual inspection in critical areas can mitigate this condition. Emphasis on minimizing flammable materials in close proximity to wiring can mitigate this condition. 3d1 Task Group 3: Specify guidlines on the separation of wire bundles from non-fire-retardant materials. **Incorporation Plan**	**OWNER**	**ECD**	**LAST**	**THIS**

3e. Contamination	Given the specified conditions, the occurrence of this fault could lead to potentially severe consequences. Wire chafing in the presence of contamination can lead to arcing, smoke and /or localized. Augmenting general visual inspection with a detailed or directed visual inspection in critical areas can mitigate this condition. Emphasis on cleaning of contaminants can mitigate the risk of enhanced flammability and aids in the inspection process. 3e1 Task Group 4: Specify enhanced standards to ensure that these wire bundles are properly protected and cleaned. **Incorporation Plan** 3e2 Aircraft Manufacturer: Consider design modification to minimize potential for contamination. **Incorporation Plan** 3e3 Other: Develop and understanding of how vibration and contamination (solid and liquid) interact. **Incorporation Plan**	**OWNER**	**ECD**	**LAST**	**THIS**
3f. Multiple critical systems	Given the specified conditions, the occurrence of this fault could lead to potentially severe consequences. Wire chafing with wires from critical systems in close proximity can lead to arcing and loss of multiple critical systems and increased crew workload. Augmenting general visual inspection with a detailed or directed visual inspection for bundles with multiple critical systems can mitigate this condition. Maintaining wiring separation for critical and redundant systems can mitigate the risk of multiple system failures. Task Group 4: Specify situation-specific separation and segregation guidelines specifically for this situation.	**OWNER**	**ECD**	**LAST**	**THIS**

	Incorporation Plan				
3g. Feeder cable	Given the specified conditions, the occurrence of this fault could lead to potentially severe consequences. Chafing of a primary power feeder cable can lead to loss of a primary power source and violent arcing with damage to other systems and structure. Augmenting general visual inspection with a detailed or directed visual inspection (emphasizing the special requirements for integrity and configuration of power feeder cables) can mitigate this condition. Nondestructive testing can detect wire chafing (after significant dielectric breakdown) and aid in expedient repair. Because there are relatively few power feeder cables, more sophisticated testing is practical and should be specified. 3g1 Task Group 3: Specify more detailed inspection and testing to ensure potential chafing problems are spotted and corrected. **Incorporation Plan** 3g2 Task Group 4: Establish specific nondestructive testing protocols for power feeder cable. Establish enhanced separation requirements specifically for this situation. **Incorporation Plan** 3g3 Aircraft Operators: Ensure awareness of best-practice considerations for feeder cables. **Incorporation Plan**	**OWNER**	**ECD**	**LAST**	**THIS**

Table 7-5-4: Cracked Insulation					
Situation	Recommendations				
4. Any situation involving one or	This finding is relatively common. Concentrations of cracks (through to the conductor) may under special circumstances result arcing or shorting.				

Table 7-5-4: Cracked Insulation					
Situation	Recommendations				
more of the conditions identified below	Visual inspection cannot be relied upon to detect cracks directly, and while testing technologies can detect certain bulk changes in insulation properties, there is no reliable and convenient means of identifying cracks. An AFCB can mitigate this condition by minimizing damage and preventing electrical fire.	**OWNER**	**ECD**	**LAST**	**THIS**
	4.1 Aircraft Manufacturers: Continue development of arc-fault circuit breaker technology. Develop generic implementation plans for the potential retrofit of arc-fault circuit breakers onto in-service aircraft. **Incorporation Plan:** 4.2 Aircraft Operators: Develop generic implementation plans for the potential retrofit of arc-fault circuit breakers onto in-service aircraft. **Incorporation Plan:** 4.3 Other: Research and develop nondestructive testing techniques capable of identifying and locating insulation cracks. Consider using these techniques for both inspection and troubleshooting of suspect wires. Consider utilization of such techniques to establish on-condition criteria for replacement of endemic cracking wire. **Incorporation Plan:**				
4a. Flammable materials, cockpit or electronics bay	Given the specified conditions, the occurrence of this fault could lead to potentially critical consequences. Though moisture may or may not be present in this scenario, the specified zones and installations within these zones are critical enough to warrant extra care and precaution. If visual inspection is used, it should be supplemented by the removal of flammable materials from these locations.	**OWNER**	**ECD**	**LAST**	**THIS**
	4a1 Task Group 3: Specify accelerated removal of flammable materials. Aircraft Manufacturers: Consider local design modification to replace non-fire-retardant materials.				

Table 7-5-4: Cracked Insulation					
Situation	Recommendations				
	Incorporation Plan: 4a2 Aircraft Operators: Accelerate removal of flammable materials from the cockpit and electronics bay. **Incorporation Plan:** 4a3 Other: Research and develop fire retarding and suppressing materials and systems for cockpit or electronics bay use. **Incorporation Plan:**				
4b. Moisture, flammable materials, multiple critical systems	Given the specified conditions, the occurrence of this fault could lead to potentially critical consequences. The potential for fire and multiple critical system failures exists. Multiple cracks in a localized area of a bundle serving multiple critical systems can also result in stray currents which adversely affect the functionality of those systems. If visual inspection is used, it should be supplemented by efforts to eliminate the potential for moisture intrusion and the removal of flammable materials. Maintaining wiring separation for critical and redundant systems can mitigate the risk of multiple system failures.	**OWNER**	**ECD**	**THIS**	**LAST**
	4b1 Task Group 3: Specify accelerated removal of flammable materials. Specify guidelines to minimize moisture intrusion into wire bundles (e.g. specify drip shields over bundles running under lavatories). Specify guidelines to minimize moisture accumulation on or near bundles. **Incorporation Plan:** 4b2 Task Group 4: Specify situation-specific wiring separation and segregation guidelines that consider loss of multiple critical functions from a common mode failure. **Incorporation Plan:**				

Table 7-5-4: Cracked Insulation					
Situation	Recommendations				
	<u>4b3 Aircraft Manufacturers:</u> Consider design modification to enhance wire separation requirements for this specific situation. Consider local design modification to replace non-fire-retardant materials. **Incorporation Plan:** <u>Aircraft Operators:</u> Accelerate removal of flammable materials. **Incorporation Plan:** <u>4b4 Other:</u> Research and develop fire retarding and suppressing materials and systems suitable for this situation. **Incorporation Plan:**				
4c. Moisture, flammable materials	Given the specified conditions, the occurrence of this fault could lead to potentially severe consequences. If visual inspection is used, it should be supplemented by efforts to eliminate the potential for moisture intrusion and the removal of flammable materials. <u>4c1 Task Group 3:</u> Specify guidlines to minimize moisture intrusion. Specify guidelines to minimize moisture accumulation on or near bundles. **Incorporation Plan:** <u>4c2 Aircraft Operators:</u> Accelerate removal of flammable materials. **Incorporation Plan:**	**<u>OWNER</u>**	**<u>ECD</u>**	**<u>LAST</u>**	**<u>THIS</u>**
4d. Moisture, multiple critical systems	Given the specified conditions, the occurrence of this fault could lead to potentially severe consequences. The potential for multiple critical system failures exists. Multiple cracks in a localized area of a bundle serving multiple critical systems can also result in stray currents which adversely affect the functionality of those systems. If visual inspection is used, it should be supplemented by efforts to eliminate the potential for moisture intrusion.				

Table 7-5-4: Cracked Insulation					
Situation	Recommendations				
	Task Group 3: Specify guidelines to minimize moisture intrusion. Specify guidelines to minimize moisture accumulation on or near bundles. **Incorporation Plan:**	**OWNER**	**ECD**	**THIS**	**LAST**
4e. Contamination, multiple critical systems	Given the specified conditions, the occurrence of this fault could lead to potentially severe consequences. Concentrations of cracks (through to the conductor) can (in the presence of some conductive contaminant) result arcing or shorting. Though flammable materials may or may not be present in this scenario, the potential for combustion (with flammable contaminants) or multiple critical system failures exists. In addition, multiple cracks in a localized area of a bundle serving multiple critical systems can also result in stray currents which adversely affect the functionality of those systems. If visual inspection is used, it should be supplemented by efforts to eliminate the potential for contamination (i.e. drip or splatter shields). 4e1 Task Group 4: Develop enhanced standards to ensure that these wire bundles are properly protected and cleaned. **Incorporation Plan:** 4e2 Aircraft Manufacturers: Consider design modification to minimize potential for contamination. **Incorporation Plan:**	**OWNER**	**ECD**	**LAST**	**THIS**

4f. Flammable materials, multiple critical systems, vibration	Given the specified conditions, the occurrence of this fault could lead to potentially severe consequences. Concentrations of large cracks (through to the conductor) can (if brought into physical contact by vibration) result arcing or shorting. In addition, vibration of cracked insulation can accelerate the degeneration of this condition. The potential for combustion or multiple critical system failures exists. In addition, multiple cracks in a localized area of a bundle serving multiple cirtical systems can also result in stray currents which adversely affect the functionality of those systems. If visual inspection is used, it should be supplemented by efforts to minimize exposure to flammable materials. Additional security (clamps, ties, etc) should be used to reduce the potential for accelerated damage and failure. Task Group 3: Specify accelerated removal of flammable materials. Establish guidelines to ensure, and enhance where necessary, the secure installation of wire bundles. **Incorporation Plan:** Aircraft Operators: Accelerate removal of flammable materials in suspect areas. **Incorporation Plan:**	**OWNER**	**ECD**	**LAST**	**THIS**

Table 7-5-5: Delamination					
Situation	Recommednations				
5. Any situation involving one or more of the conditions identified below	This finding is relatively infrequent. Delaminations (through to the conductor) may under special circumstances result arcing or shorting. Visual inspection may not be able to detect delamination. (Data on the visual detectability of delamination is very limited.) If visual inspection is used, it should be supplemented by efforts to eliminate the potential for moisture intrusion and efforts to minimize exposure to flammable materials. An AFCB can mitigate this condition by minimizing damage and preventing electrical fire.				

		OWNER	ECD	LAST	THIS
	5.1 Task Group 3: Specify guidelines that precipitate an invasive inspection or nondestructive testing of wire bundles exposed to suspected high or low pH contaminants. Specify guidelines for decontamination procedures for wire to neutralize the effects of chemically aggressive contaminants. **Incorporation Plan:** 5.2 Aircraft Manufacturers: Continue development of arc-fault circuit breaker technology. Develop generic implementation plans for the potential retrofit of arc-fault circuit breakers onto in-service aircraft. **Incorporation Plan:** 5.3 Operators: Specify maintenance procedures and training to instruct technicians on use of techniques to identify suspect wires. **Incorporation Plan:** 5.4 Other: Specify use of in-situ indicators to identify exposure to precipitating agents or conditions – a “canary”. (In particular, use in-situ litmus testing to identify exposure of wrapped construction wire to high or low pH solutions or contaminants.) Develop updated wiring separation guidelines that consider loss of multiple critical functions from a common mode failure. **Incorporation Plan:**				

5a. Flammable materials, cockpit or electronics bay	Given the specified conditions, the occurrence of this fault could lead to potentially critical consequences. Though moisture may or may not be present in this scenario, the specified zones and installations within these zones are critical enough to warrant extra care and precaution. 5a1 Aircraft Manufacturers: Consider design modification to eliminate non-fire-retardant materials. **Incorporation Plan:** 5a2 Operators: Accelerate removal of flammable materials. **Incorporation Plan:**	**OWNER**	**ECD**	**LAST**	**THIS**

Table 7-5-6: Arcing					
Situation	Recommendations				
6. Any situation involving one or more of the conditions identified below.	This finding is relatively infrequent. Arcing can result from degraded or damaged wire or non-environmental or degraded splices. Because visual inspection will probably not detect initial arcing, efforts should focus on minimizing wire exposure to chafing, traumatic impact during maintenance operation in the area. Use of environmental splices can reduce the potential for a hazardous arc. Use of an AFCB can mitigate the consequences of arcing. Operational procedures, including Flight Standards Information Bulletin 00/08A, can also mitigate the consequences of initial failure. 6.1 Task Group 5: Develop guidelines that ensure that all maintenance personnel, not just electrical maintenance technicians, are made aware of those actions that could result in breached wire. Small breaches (such as those resulting from the needling of wire) should not be dismissed as inconsequential. **Incorporation Plan:** 6.2 Aircraft Manufacturers: Continue development of arc-fault circuit breaker technology. Develop generic implementation plans for the	**OWNER**	**ECD**	**LAST**	**THIS**

Table 7-5-6: Arcing					
Situation	Recommendations				
	potential retrofit of arc-fault circuit breakers onto in-service aircraft. **Incorporation Plan:** 6.3 Operators: Develop generic implementation plans for the potential retrofit of arc-fault circuit breakers onto in-service aircraft. Make maintenance personnel aware of the dangers of arcing. **Incorporation Plan:** 6.4 Other: Continue research necessary to support the development of arc-fault circuit breakers and incorporate AFCB into other circuit switching devices and selected electrical components. Conduct research into other technologies that mitigate the risk of arcing. **Incorporation Plan:**				
6a. Flammable materials, cockpit or electronics bay	Given the specified conditions, the occurrence of this fault could lead to potentially critical consequences. The existence of an arcing condition in the presence of flammable materials is unacceptable. The cockpit and electronics bay warrant special attention. Elimination of flammable materials can mitigate the consequences of arcing. 6a1 Operators: Accelerate removal of flammable materials from the cockpit and electronics bay. **Incorporation Plan:**	**OWNER**	**ECD**	**LAST**	**THIS**

6b. Flammable materials, multiple critical systems	Given the specified conditions, the occurrence of this fault could lead to potentially critical consequences. The existence of an arcing condition in the presence of flammable materials is unacceptable. In addition to the fire threat, multiple critical systems may fail. Elimination or segregation of flammable materials can mitigate the consequences of arcing. 6b1 Operators: Accelerate removal of flammable materials. Ensure separation of wire bundles from flammable materials. **Incorporation Plan:**	**OWNER**	**ECD**	**LAST**	**THIS**
6c. Contamination, cockpit or electronics bay	Given the specified conditions, the occurrence of this fault could lead to potentially critical consequences. The existence of an arcing condition in the presence of flammable contaminants is unacceptable. The cockpit and electronics bay warrant special attention. Exposure of wire to fluid contaminants (e.g. water waste, hydraulic) and solid debris (e.g. drill shavings, foreign objects) must be minimized. Susceptible wire bundles should be kept free of flammable dust and lint build-up. 6c1 Aircraft Manufacturers: Consider design modification to minimize potential for contamination. **Incorporation Plan:** Operators: Use additional precautions when performing maintenance in the cockpit and electronics bay. **Incorporation Plan:**	**OWNER**	**ECD**	**LAST**	**THIS**

6d. Contamination, multiple critical systems	Given the specified conditions, the occurrence of this fault could lead to potentially critical consequences. The existence of an arcing condition in the presence of flammable contaminants is unacceptable. Exposure of wire to fluid contaminants (e.g. water waste, hydraulic) and solid debris (e.g. drill shavings, foreign objects) must be minimized. Susceptible wire bundles should be kept free of flammable dust and lint build-up. 6d1 Aircraft Manufacturers: Consider design modification to minimize potential for contamination. **Incorporation Plan:** 6d2 Operators: Use additional precautions when performing maintenance in the vicinity of wire bundles supporting multiple flight-critical systems. **Incorporation Plan:**	**OWNER**	**ECD**	**LAST**	**THIS**
6e. Multiple critical systems, arc-tracking potential	Given the specified conditions, the occurrence of this fault could lead to potentially critical consequences. Though this scenario does not assume the presence of flammable materials or contaminants, arc-tracking on a bundle with multiple critical system wires can result in multiple flight-critical system failures. Separation of critical wiring into physically separate and smaller bundles can reduce the possibility of cascading failure. 6e1 Task Group 4: Specify enhanced separation requirements for wires with known arc-tracking potential. Specify enhanced routing requirements for wires with known arc-tracking potential that prohibit or minimize hazardous conditions such as chaffing, or damage from regular activities in/about the aircraft. **Incorporation Plan:**	**OWNER**	**ECD**	**LAST**	**THIS**

General Recommendation

There are many ATSRAC supported activities that will result in great improvement to the inspection and maintenance of aircraft electrical systems. The recommendations stemming from these activities are extremely important. The following general recommendation is meant to supplement those other recommendations. This recommendation should be considered in conjunction with those recommendations without any presumption regarding priority or importance:

> Inspection and maintenance personnel should be made aware of the characteristic degenerative failure modes for specific wire types. Furthermore these personnel should be made aware of the types of wire they are likely to encounter on the aircraft they maintain. Task Group 5 should implement this recommendation by including appropriate material in their proposed training curricula.

OWNER	ECD	LAST	THIS
FAA (who ?)			

Research Recommendations of the Intrusive Inspection Working Group

The intrusive inspection project is only a first look at state of wire in aged aircraft. As with most investigative studies of this nature, it answered some questions, failed to fully answer other questions, and raised still more questions. Cognizant of the results of this project, the working group makes the following recommendations for further research:

- The FAA should fully support its commitment to its wire degradation assessment project to begin this year. With reference to this report, the degradation assessment project should attempt to explain observed or suspected – but yet unanalyzed – phenomena on the dominant aged wire types. This research should focus on characteristic failure modes and the factors that aggravate or retard degradation. The goal of such research should be a methodology that allows us to predict with a high degree of certainty the fitness for service of wire subject to a known service environment.

  As part of the degradation assessment project the FAA should analyze the effects of wire-to-wire chaffing. Wires are currently selected by the aircraft manufacturer based on their specific application and their proximity to other wires in a bundle. Maintenance and subsequent modifications may result in the mixing of wire types not anticipated during original design. There is lingering concern that wires with different insulations can damage each other if bundled together. Building upon the work of the Navy Avionics Center report TR 2333 and Airbus investigations into this issue, this suspicion should be re-examined.

  Also as part of the degradation assessment project the FAA should analyze the effects of common contaminants on wire. Special attention should be paid to corrosion control compounds.

  This follow-on effort should be fully consistent with and build upon the work presented in the Intrusive Inspection Working Group Report. In particular, the analysis of wire bundles taken from retired aircraft is an essential part of any such effort. The FAA should consider pursuing further laboratory testing per the intrusive inspection protocol on the currently available specimens. This would include:

  - Perform additional laboratory visual analysis of 747-, L1011-, and A300- specimens.
  - Perform additional laboratory tests based on original intrusive inspection laboratory test protocol.
  - Investigation of the effects of lavatory fluid contamination of PVC insulation. Also investigate other fluids/chemicals used in aircrafts.
  - Determine probable cause of the observed degenerative conditions (e.g. internal or external heating, fluid contamination, aging).

- For PVC/Glass/Nylon, correlate the specific symptoms of aging with the mechanical and electrical properties of the insulation.
-

<u>**OWNER**</u>	<u>**ECD**</u>	<u>**LAST**</u>	<u>**THIS**</u>
FAA (who ?)			

- Excessive wire heating presents the risk of electrical fire or ignition of surrounding combustible materials. High resistance inter-connections where electrical heating is sufficient to damage the wire insulation are typically detected by visual inspection for embrittled, charred or missing insulation. However, the relationship of observable thermal damage to wire hot enough to hazard the aircraft is still unknown. It is recommended that the FAA conduct research to determine how best to manage this issue.

<u>**OWNER**</u>	<u>**ECD**</u>	<u>**LAST**</u>	<u>**THIS**</u>
FAA (who ??)			

- The FAA should aggressively pursue and promote arc-fault circuit breaker development. Many of the recommendations of this report specify this as a potential option to eliminate or mitigate electrical hazards.

<u>**OWNER**</u>	<u>**ECD**</u>	<u>**LAST**</u>	<u>**THIS**</u>
FAA (Pappas)			

- The FAA should aggressively pursue and promote the development of nondestructive test equipment for aircraft wiring. Many of the recommendations of this report specify this as a potential option to eliminate or mitigate electrical hazards.

<u>**OWNER**</u>	<u>**ECD**</u>	<u>**LAST**</u>	<u>**THIS**</u>
FAA (who ??)			

- By their very nature connectors and terminals are designed to be serviceable, and they are physically localized. This suggests that these components should be less problematic than wires, which may stretch from one end of the aircraft to the other. On the other hand their relatively frequent handling and exposure to collateral damage, make connectors, terminals, their lead wires subject to repetitive stress and accidental damage. Furthermore, experience has shown that we cannot rule-out the possibility of a fire resulting from a defective or broken connector.

  The intrusive inspection project did not fully consider connector issues. The military and commercial aviation community should sponsor efforts to scope the problem and establish research projects and maintenance guidelines to address the issue.

<u>**OWNER**</u>	<u>**ECD**</u>	<u>**LAST**</u>	<u>**THIS**</u>

- Though wires and connectors are the most obvious component in electrical interconnect systems, there are others. The FAA should investigate the physical and functional integrity of any electrical system component whose failure could hazard the aircraft. This includes: circuit breakers, relays, switches, wire support and bundling systems (including conduit), shielding, ground blocks, etc.

OWNER	**ECD**	**LAST**	**THIS**
FAA (who ??)			

- The working group observed wires with breaches and non-environmental splices, and found reduced insulation resistance in certain wet wires. Though the working group did not document wire bundles with numerous, collocated breaches or non-environmental splices, the possibility should be considered. In the presence of moisture this situation could result in stray electrical currents affecting multiple systems. The FAA should investigate the possibility of this situation and its potential to hazard the aircraft.

OWNER	**ECD**	**LAST**	**THIS**
FAA (who ??)			